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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/826,458	04/05/2001	X.-C. Zhang	RPI-103US38	6513

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EXAMINER	
LEE, SHUN K	

ART UNIT	PAPER NUMBER
2878	

DATE MAILED: 10/03/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/826,458	ZHANG ET AL.	
	Examiner	Art Unit	
	Shun Lee	2878	

-- The MAILING DATE of this communication appears on the cover sheet with th correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *30 June 2003* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *2-16 and 18-26* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *2-16 and 18-26* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *7/11/01 & 6/30/03* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Drawings

1. The drawings were received on 30 June 2003. These drawings are acceptable.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 2-7, 10, 11, 18-20, 23, and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Eloy (US 6,275,045) in view of Wu *et al.* (Applied Physics Letters 67:3523-3525, 1995), Nahata *et al.* (Applied Physics Letters 69:2321-2323, 1996), Cai *et al.* (Applied Physics Letters 73:444-446, 1998), and Bromage *et al.* (US 6,239,866).

In regard to claim **4**, Eloy discloses (column 4, lines 42-51) a system for emitting and detecting one or more terahertz frequency electromagnetic pulses (column 1, lines 45-48), the system comprising a single transceiver device (301 in Fig. 8; column 6, lines 44-53) for both emitting and detecting the pulses. Eloy also discloses (column 1, lines 45-63; column 4, lines 42-51) an optical source (304 in Fig. 8 or 104 in Fig. 2) and related optics (27 in Fig. 2) for providing: (a) a plurality of pump pulses to excite the transceiver (301 in Fig. 8) to emit a corresponding plurality of terahertz output pulses, and (b) a plurality of probe pulses timed to illuminate the transceiver (301 in Fig. 8) simultaneously with a corresponding plurality of reflected terahertz pulses; and an object (*i.e.*, medium being studied; column 2, lines 53 and 54) which is illuminated by the terahertz output pulses and reflects the plurality of reflected terahertz pulses; an amplifier (21 in Fig. 8) for receiving a plurality of electrical signals, each signal carrying information proportional to a corresponding reflected terahertz pulse as detected by the transceiver (301 in Fig. 8).

The system of Eloy lacks that the amplifier is a lock-in amplifier having a reference input connected to a clock output of a chopper which modulates the terahertz output pulses at a first frequency, and the lock-in amplifier is auto-locked to the first frequency so as to reduce noise in the plurality of electrical signals. Lock-in amplification (*i.e.*, a lock-in amplifier having a reference input connected to a clock output of a chopper which modulates output pulses at a first frequency to which the lock-in amplifier is auto-locked) is well known in the art. For example, Wu *et al.* teach (first paragraph in left column on pg. 3524) lock-in amplification with a chopper and a

lock-in amplifier for noise reduction. As another example, Nahata *et al.* teach (Fig. 2) lock-in amplification with a chopper and a lock-in amplifier. As still another example, Cai *et al.* teach (Fig. 1; last paragraph in right column on pg. 444 to second paragraph in left column on pg. 445) lock-in amplification with a chopper (AOM) and a lock-in amplifier (lock-in) in order to obtain a better SNR. As a further example, Bromage *et al.* teach (column 1, line 66 to column 2, line 45) to modulated THz output pulses with an attenuator (12 in Fig. 1) at a frequency Ω which is measured with a lock-in amplifier at frequency Ω in order to provide an improved measurement of THz pulses. Therefore it would have been obvious to one having ordinary skill in the art to use lock-in amplification in the system of Eloy wherein the THz output pulses are modulated either before or after generation, in order to obtain a better SNR and to provide an improved measurement of THz pulses.

In regard to claim **18**, the method steps are implicit for the modified apparatus of Eloy since the structure is the same as the applicant's apparatus of claim 4 above.

In regard to claim **2** which is dependent on claim 4, the system of Eloy lacks that that the single transceiver device comprises an electro-optic crystal wherein a reflected modulated probe pulse is detected by a photodetector. THz radiation generators and detectors are known in the art. For example, Wu *et al.* teach (first paragraph, right column on pg. 3523; Fig. 1) to substitute an electro-optic crystal wherein a reflected modulated probe pulse is detected by a photodetector for a photoconductive antenna in order to extend the bandwidth for both generation and detection of THz radiation. As another example, Nahata *et al.* teach (first two paragraphs, left column on pg. 2321) to

substitute an electro-optic crystal for a photoconductive antenna in order to extend the bandwidth for both generation and detection of THz radiation. As still another example, Cai *et al.* teach (first paragraph, left column on pg. 444; Figs. 2 and 3) that the substitution of an electro-optic crystal for a photoconductive antenna provides the advantage of a higher detection bandwidth. Therefore it would have been obvious to one having ordinary skill in the art to substitute an electro-optic crystal for the photoconductive antenna in the system of Eloy, in order to extend the bandwidth for both generation and detection of THz radiation.

In regard to claim **3** which is dependent on claim 4, Eloy also discloses (Fig. 8) that the single transceiver device (301) comprises a photoconductive antenna (column 1, lines 49-64).

In regard to claim **5** which is dependent on claim 4, Eloy also discloses (column 6, lines 4-10) one or more parabolic mirrors between the transceiver and the object.

In regard to claim **6** which is dependent on claim 4, Eloy also discloses (Fig. 8) that the transceiver (301) is a photoconductive antenna (column 1, lines 49-64) that produces the electrical signals received by the amplifier (21), each electrical signal produced when a probe pulse and a reflected terahertz pulse simultaneously illuminate (column 4, lines 1-22) the antenna (303).

In regard to claim **10** which is dependent on claim 4, Eloy in view of Wu *et al.*, Nahata *et al.*, and Cai *et al.* is applied as in claim 2 above.

In regard to claim **7** (which is dependent on claim 6) and claim **11** (which is dependent on claim 10), Eloy also discloses (Fig. 1) a data processor (20) for processing the output signal from the amplifier (21).

In regard to claims **19** and **20** which are dependent on claim 18, Eloy in view of Wu *et al.*, Nahata *et al.*, and Cai *et al.* is applied as in claims 2 and 7 above.

In regard to claims **23** and **24** which are dependent on claim 18, Eloy in view of Wu *et al.*, Nahata *et al.*, and Cai *et al.* is applied as in claims 3 and 7 above.

5. Claims 8, 9, 12, 13, 21, 22, 25, and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Eloy (US 6,275,045) in view of Wu *et al.* (Applied Physics Letters 67:3523-3525, 1995), Nahata *et al.* (Applied Physics Letters 69:2321-2323, 1996), Cai *et al.* (Applied Physics Letters 73:444-446, 1998), and Bromage *et al.* (US 6,239,866) as applied to claims 7, 11, 20, and 24 above, and further in view of Mittleman *et al.* (US 6,078,047).

In regard to claims **8** and **9** (which are dependent on claim 7), claims **12** and **13** (which are dependent on claim 11), claims **21** and **22** (which are dependent on claim 20), and claims **25** and **26** (which are dependent on claim 24), the modified system and method of Eloy lacks that the data processor is adapted to produce an image based upon a peak amplitude of each of the reflected pulses or a tomographic image based upon a difference in time between the reflected pulses from different layers of the object. Mittleman *et al.* teach (column 1, lines 16-56) that it is known in the art to use terahertz electromagnetic waves for imaging with transmitted or reflected power (*i.e.*, peak amplitude of each of the reflected pulses) and further teach that a difference in

time between the reflected pulses can also be used to provide a depth resolved compositional image. Therefore it would have been obvious to one having ordinary skill in the art to use the modified system and method of Eloy to obtain images from either the peak amplitude of each of the reflected pulses or the difference in time between the reflected pulses from different layers of an object.

6. Claims 14-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Eloy (US 6,275,045) in view of Wu *et al.* (Applied Physics Letters 67:3523-3525, 1995), Nahata *et al.* (Applied Physics Letters 69:2321-2323, 1996), Cai *et al.* (Applied Physics Letters 73:444-446, 1998), and Bromage *et al.* (US 6,239,866) as applied to claim 2 above, and further in view of Onstott *et al.* (US 4,896,942).

In regard to claim **14-16** which is dependent on claim 2, the system of Eloy lacks that the electro-optic crystal has a volume of less than about 1 mm^3 and is mounted to the end of a polarization-preserved optical fiber. Nahata *et al.* teach (last paragraph in left column on pg. 2322) that pump beam should be polarized at an angle relative to a crystallographic axis of the electro-optic crystal in order to maximize the non-linear response. Eloy also discloses (column 3, lines 59-64) that optical fibers can be used for guiding the optical pulses. Optical fibers such as polarization-preserved optical fibers are well known in the art. For example, Onstott *et al.* teach (column 1, lines 13-21) it is known in the art that polarization-preserved optical fibers have a 3-10 μm diameter core and a 80-125 μm diameter jacket. Further, Cai *et al.* teach (second paragraph in right column on pg. 445) that the thickness of an electro-optic crystal should be selected based on the desired trade-off between sensitivity and frequency response (*e.g.*,

2.2 mm thick ZnTe electro-optic crystal). Therefore it would have been obvious to one having ordinary skill in the art to mount an electro-optic crystal on a conventional polarization-preserved optical fiber in the modified system of Eloy, in order to deliver optical pulses with a desired polarization angle relative to the crystallographic axis of the electro-optic crystal so as to maximize the non-linear response and wherein the electro-optic crystal dimensions (*i.e.*, volume of less than about 1 mm^3) are matched to the optical fiber diameter (*e.g.*, ~125 μm) with the electro-optic crystal thickness (*e.g.*, ~2.2 mm) selected to obtain a desired sensitivity and frequency response.

Response to Amendment

7. The declaration under 37 CFR 1.132 filed 30 June 2003 is sufficient to overcome the rejection of claims 2, 4-7, 10, 11, 18-20, 23, and 24 based upon Eloy in view of Wu *et al.*, Nahata *et al.*, and Cai *et al.*

Response to Arguments

8. Applicant's arguments, see last two paragraphs on pg. 11 to first two paragraphs on pg. 12 of applicant's remarks, filed 30 June 2003, with respect to the rejection(s) of claim(s) 4 and 18 under 35 U.S.C. 103(a) as being unpatentable over Eloy in view of Wu *et al.*, Nahata *et al.*, and Cai *et al.* have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of the newly found prior art reference Bromage *et al.* (US 6,239,866) wherein the THz pulse is modulated.

Conclusion

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shun Lee whose telephone number is (703) 308-4860. The examiner can normally be reached on Monday-Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Porta can be reached on (703) 308-4852. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9318 for regular communications and (703) 872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

CONSTANTINE HANNAHER
PRIMARY EXAMINER
GROUP ART UNIT 2878

SL
September 16, 2003